Redundant Group Control for FM or IR units

Redundant Group Control or RGC is a collection of two, three or four systems that provide redundant functionality, runtime balancing, prevention of demand fighting, load sharing, setpoint sharing and backflow prevention. In order to better understand RGC, we need to define the different components of the group:

A **Module** is an independent, Computer Room Air Conditioner. A **System** is a set of one to three Modules operating based on the average temperature and humidity of all the modules in that system. The modules in a system work together as a single unit and up to three modules can be used in a system to increase the system's cooling capacity. A **Group** is a set of two, three or four Systems that work together to provide redundancy.

In a system one of the modules is designated by the user as the "Main Module" and the rest of modules in the systems are identified as "Expansion Modules". The main module is the controller for all the modules in the system and it contains the PCIOM boards, the Network Management Card and establishes communications with the BMS.

To enable the modules to work in a system or group, the only requirement is to connect them together with a CAT 5 cable terminated with RJ-45 connectors and to setup the dip switches on the controller board of each module to assign the main module, the expansion modules and the System number. For more information on the dip switches set up, see the Installation Manual.

The systems belonging to a particular group should be located in close proximity in order for the backup systems to service the load properly to that area.

In a Group, the **Primary Systems** are the systems designated to actively control the environment and the **Back up Systems** are designated to remain idle and only provide environmental control upon request.

When a Primary system fails, a Backup system will automatically take over its duties; this process is called Failover. The user must select from a set of System Failures the events that will cause a primary system to failover. This selection must be configured for each system in the group and System Failures for one system do not necessarily have to be the same ones for other systems in the group.
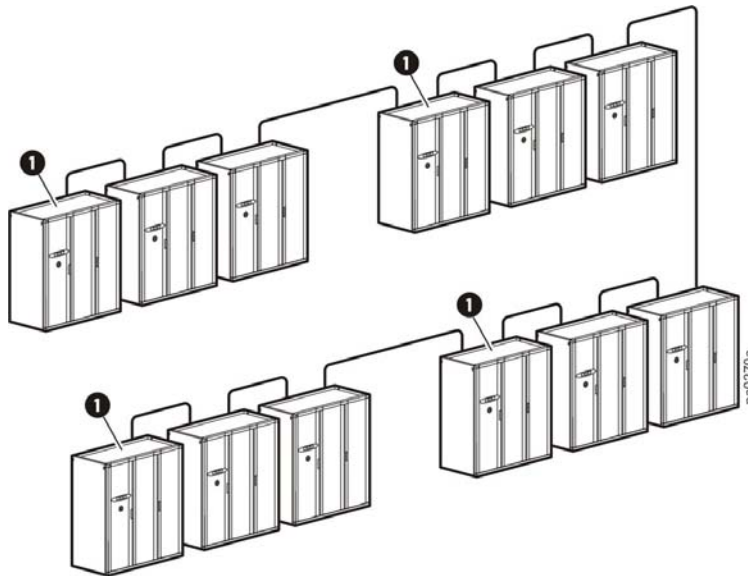
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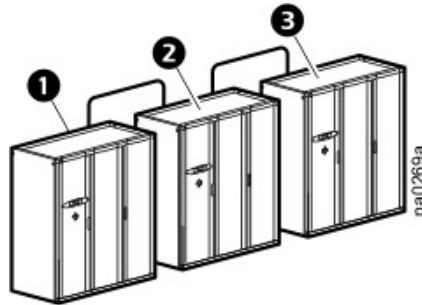
S Y S T E M

① MAIN MODULE
② EXPANSION MODULE 1
③ EXPANSION MODULE 2

① MAIN MODULE

G R O U P

Figure 1 – Modules, Systems and Group

Redundant Group Control (RGC)

Each system has a "Group status", which refers to how that system is interacting with the group. The group status for a system can be Online, Idle, Share, Failed or Offline.

When the system is **"Online",** the system is actively controlling the environment.

If the status is **"Idle"**, the system is not active but it is available to take over for a failed system or assist with environmental control if called upon. When the system status is **"Share"**, the system is assisting other systems with environmental control. The Idle and Share status only apply to backup systems**.**

A **"Failed"** status indicates that the system has experienced a System Failure Event, which is triggered by the activation of a user selected event. To restore a system from the failed status, the source of the event has to be corrected and the state of failure has to be reset manually.

The **"Offline"** status means that the system has been turned off either at the PowerView User Interface, by a remote run/stop, immediate shutdown or if a fire or smoke alarm has occurred.

For Redundancy operation, the user has to define the events that will cause a Failover and only those events will trigger a switchover to a Back-up system. The controller has a default configuration of events that will cause a failover; this configuration can be modified to add more events to trigger a switchover or to disable any default event.

Table 1 and Table 2 define the events that the user can choose to cause a switchover to a Back-up System.

- The column named *MAP* indicates if the event is a system event or a module event. If the event is a module event, then an occurrence of that event on **any** module of the system will cause a switchover.
- The column named *EVENT NAME* indicates the name of the event as it appears on PowerView.
- The column named *CONSISTS OF* indicates the set of events that comprise the Event Name. For example, if the Maintenance Required event is chosen, then any of the events listed in the corresponding **Consists of** column will cause a switchover.
- The *DEFAULT* column indicates the factory default setting. A value of **Enabled** means the occurrence of the event will trigger a switchover.

Features of the Redundant Group Control

The Redundant Group Control has additional features that are designed to provide flexibility in managing a group. These features are:

Runtime Balancing

When this feature is enabled, the primary systems and backup systems will periodically swap roles. A primary and backup system will swap roles when the primary system's runhours exceeds a backup system's runhours by 72 hours.

For this feature, the user specifies the number of Primary systems in the group and the total number of systems for that group. The controller will automatically assign roles. If Runtime balancing is disabled, the user must still select the number of systems in the group and assign the systems roles manually.

Runtime Balancing only occurs if there are no abnormal conditions in the group, such as Failed or offline systems or no communication alarms. If an abnormal condition exists, then the need for redundancy takes precedence and the backup unit will run until the failure or abnormal condition is corrected.

Load sharing

Load sharing or "LS" allows Primary systems to request assistance from Backup systems in controlling the environment. If primary systems are unable to maintain temperature or humidity, the backup system will start and continue to run until the demand is satisfied. For example, if there is the need for humidification capacity beyond what primary systems are able to supply, the backup system will turn on its humidifier until the humidity levels are satisfied.

It is important to take into account, that when Load sharing is enabled, the user must have sufficient power and utilities for all the systems in the group to be working at once, since during load sharing, all the systems including backup systems might be on line.

When Load Sharing is enabled for a function, the threshold at which assistance is requested has to be set up for the functions to be enabled. Cooling/dehumidifying load sharing does not start until the temperature/humidity levels exceed the sum of the threshold value and the temperature/humidity setpoint. Note that in order to have load sharing for dehumidification, the system will have to be enabled also for cooling load sharing.

Reheat/humidifying load sharing does not start until the temperature/humidity levels fall below the difference between the temperature/humidity setpoint and the threshold value.

Demand Fighting

When Demand Fighting is enabled, reheat will be inhibited on all the systems in the group when cooling is active on any system in the group, avoiding conflicting modes of operation within the group.

Setpoint sharing

Humidification and dehumidification setpoints are always shared among all the systems in the group, while reheat and cooling are not. If the Setpoint sharing feature is enabled, then the setpoints and deadbands for cooling and reheat are the same for all the systems in the group and if a setpoint is changed on any unit in the group, the whole group's' setpoints will change.

Reverse Airflow Prevention

This is a feature of the Redundant Group Control that applies to units installed in a raised floor application. In this case, while the backup unit is in "idle" mode, not providing any active role, the unit maintains the fans rotating at a reduced speed of 20 Hz, to avoid having any reverse flow or backflow thru the unit from the raised floor which is pressurized by the "active" units working in the group. In order to enable this feature the "Idle Blower Speed" has to be set up to minimum.

Group Fire and Smoke Alarm

This feature shuts down the entire group when a fire or smoke alarm is detected by any system in the group.

Communication Loss Failover

When this feature is enabled, the loss of communications with one unit will be treated as a failure and a backup system will take over its functions. Note that when this failure is corrected, the Primary system will automatically return to the online state.

Additional Notes on the Redundancy function

If Load Sharing is enabled for cooling in a group and an "online" system is ready to be on "backup" mode due to runtime balancing hours, there will be a five minute handoff period; where the newly designated backup system will continue to run for an additional five minutes before becoming idle in order to make sure that the new online system is working properly.

Following the same procedure, if LS cooling is enabled, and a system fails, the failed system will be shutdown after a five minute handoff period to make sure that the backup system is working properly. This will occur if the failure of the system does not require immediate shutdown of the unit.

If LS cooling is not enabled, the controller assumes that power or utilities are not available for all systems at once and therefore the backup system will come online and the Failed system will shutdown immediately.

If there is no Backup system available to come on line, the Failed System will not shutdown.

When a Failed system or Offline primary system returns to the Online state, an Online Backup system will return to the Idle state. This will only occur if there are no other Failed or Offline Primary systems requiring backup.

Recommendations and Conclusions

It is important to consider the specific job requirements, setup and lay-out of the cooling units when selecting the features offered by the Redundant Group Control to obtain the best possible group and redundancy operation.

Even though up to three modules can be assigned to a system and therefore up to twelve modules can be controlled in a group; in most applications there is only one or two modules assigned per system which results in four to eight modules per group, which is a reasonable number of units in close proximity in a data center to work as a redundant group.

Map	Event Name	Consists of	Default
System	Any Alarm	Any minor or major alarm in the system	Disabled
System	High Environmental	High Environmental Temperature	Disabled
System	Low Environmental	Low Environmental Temperature	Disabled
System	High Environmental Humidity	High Environmental Humidity	Disabled
System	Low Environmental Humidity	Low Environmental Humidity	Disabled
System	Fire	Fire	Disabled
System	Smoke	Smoke Detected	Disabled
System	Module Comm Loss	Comm Loss with Expansion Module #1 Comm Loss with Expansion Module #2	**Enabled**
System	Supply Sensor Failure	Supply Sensor Failure	Disabled
System	Return Sensor Failure	Return Sensor Failure	Disabled
System	Primary Sensor Failed	Primary Sensor Failed	Disabled
System	Secondary Sensor Failed	Secondary Sensor Failed	**Enabled**
Module	Maintenance Required	Compressor 1 Maintenance Required Compressor 1 Maintenance Required Heater Maintenance Required Humidifier Maintenance Required Blower 1 Maintenance Required Blower 2 Maintenance Required VFD 1 Maintenance Required VFD 2 Maintenance Required	Disabled
Module	Cooling Failure	Water Regulator Actuator Failure PC/Multicool Actuator Failure High Head Pressure Low Suction Pressure High Suction Pressure Loss of Coolant Flow to Multi-Cool Coil Loss of Coolant Flow to Condenser (Econ Coil) Inlet MC/Econ Water Temperature High Inlet MC/Econ Water Temperature Low Inlet MC/Econ Temperature Sensor Failure	**Enabled**
Module	Humidifier Failure	Humidifier High Water Conductivity Humidifier Excessive Foaming Humidifier High Current Humidifier No Power Humidifier Internal Memory Error Humidifier Lack of Water Humidifier Excessive Output Reduction Humidifier Drain Malfunction Humidifier Cylinder Full When Unit Off Humidifier Replace Cylinder Humidifier Fault Tolerance Exceeded	**Enabled**
Module	High Filter Differential Pressure	High Filter Differential Pressure	Disabled
Module	High Supply Temperature	High Supply Temperature	Disabled
Module	Low Supply Temperature	Low Supply Temperature	Disabled
Module	High Supply Humidity	High Supply Humidity	Disabled
Module	Low Supply Humidity	Low Supply Humidity	Disabled
Module	Loss or Low Airflow	Loss or Low Airflow	**Enabled**
Module	Humidifier Replace Cylinder	Humidifier Replace Cylinder	Disabled

Table 1 – Group Failover Mappings

Map	Event Name	Consists of	Default
Module	VFD 1 Failure	VFD 1 Over Current During Acceleration VFD 1 Over Current During Deceleration VFD 1 Over Current During Steady Operation VFD 1 Over Voltage During Acceleration VFD 1 Over Voltage During Deceleration VFD 1 Over Voltage During Steady Operation VFD 1 DC Under Voltage VFD 1 Power Supply Open Phase VFD 1 Output Wiring Error VFD 1 Heat Sink Over Temp VFD 1 Motor 1 Overload VFD 1 Overload VFD 1 Overheat Outside Thermal VFD 1 Overheat DB Resistor VFD 1 Motor 2 Overload VFD 1 Memory Error VFD 1 Keypad Transmission Error VFD 1 CPU Error VFD 1 Option Communication Error VFD 1 Option Error VFD 1 PL Error VFD 1 RS485 Communication Error VFD 1 Fault Tolerance Exceeded	**Enabled**
Module	VFD 2 Failure	VFD 2 Over Current During Acceleration VFD 2 Over Current During Deceleration VFD 2 Over Current During Steady Operation VFD 2 Over Voltage During Acceleration VFD 2 Over Voltage During Deceleration VFD 2 Over Voltage During Steady Operation VFD 2 DC Under Voltage VFD 2 Power Supply Open Phase VFD 2 Output Wiring Error VFD 2 Heat Sink Over Temp VFD 2 Motor 1 Overload VFD 2 Overload VFD 2 Overheat Outside Thermal VFD 2 Overheat DB Resistor VFD 2 Motor 2 Overload VFD 2 Memory Error VFD 2 Keypad Transmission Error VFD 2 CPU Error VFD 2 Option Communication Error VFD 2 Option Error VFD 2 PL Error VFD 2 RS485 Communication Error VFD 2 Fault Tolerance Exceeded	**Enabled**
Module	Air Block Interlock Open	Air Block Interlock Open	**Enabled**
Module	Water Detected	Water Detected	Disabled
Module	Condensate Pump Failure	Condensate Pump Failure	**Enabled**
Module	Any Alarm	Any minor or major alarm in the module	Disabled

Table 2 – Group Failover Mappings